Production of ^{272}111 in the ^{208}Pb(^{65}Cu, *n*) Reaction

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The production of odd-Z heavy elements has generally been accomplished using neutron-rich even-Z projectiles with ^{209}Bi targets. For example, the projectiles ^{54}Cr, ^{58}Fe, and ^{64}Ni have been used to successfully produce elements 107, 109, and 111, respectively (for a summary see Ref. [1]). These reactions are used because of their higher compound nucleus formation probability relative to the analogous reaction using an odd-Z projectile with a ^{208}Pb target. The goal of the current work was to quantify this effect by measuring the cross section of the ^{208}Pb(^{65}Cu, *n*)^{272}111 reaction for the first time.

In order to better estimate the beam energy for optimum production of ^{272}111, the excitation function of the ^{208}Pb(^{64}Ni, *n*)^{271}Ds reaction was measured first [2] to establish a reference for the current work. A conventional model [3] was used to estimate that the maximum of the ^{65}Cu + ^{208}Pb reaction should occur at a beam energy 9.6 MeV higher (in the lab frame) than the ^{64}Ni + ^{208}Pb reaction. Thus, the lab-frame center-of-target $^{65}Cu^{15+}$ energy (E_{cot}) in the current work was chosen to be 321.1 MeV, compared to 311.5 MeV in Ref. [2]. The corresponding compound nucleus excitation energy was 13.2 MeV (masses taken from Ref. [4]). The target thickness was 470 μg/cm^2 (98.4% ^{208}Pb, 1.1% ^{207}Pb, 0.5% ^{206}Pb), and the total ^{65}Cu dose delivered to the target was 6.6×10^{17}.

One event of interest was observed and is shown in Fig. 1. A 28.58-MeV implantation event in strip 18 was followed 0.263 ms later by a high-energy alpha decay with energy 11042 keV. After an additional 12.6 ms, another alpha particle was observed with energy 10114 keV. These three events provide strong evidence for the presence of a high-Z element and agree well with the data in Ref. [5-6] on the decay of ^{272}111 and ^{268}Mt. Thus, this event is assigned to ^{272}111.

Three additional alpha decays were observed following the ^{268}Mt decay and are assigned to ^{264}Bh, ^{260}Db, and ^{256}Lr. The decreasing position resolution observed can be attributed to the small amount of energy deposited in the main focal plane detector by the escaping alpha particles. No other alpha particles with energy greater than 1 MeV were observed in this strip during the 150 s following the implantation event.

From the one observed event, the measured cross section of the ^{208}Pb(^{65}Cu, *n*)^{272}111 reaction was $1.7^{+3.9}_{-1.4}$ pb at E_{cot} = 321.1 MeV. The observed evaporation residue magnetic rigidity in helium was 2.10 T m. This experiment provides an independent confirmation of the discovery of element 111 in a new reaction and shows the promise of using more economical, higher abundance odd-Z projectiles for the production of odd-Z heavy elements.

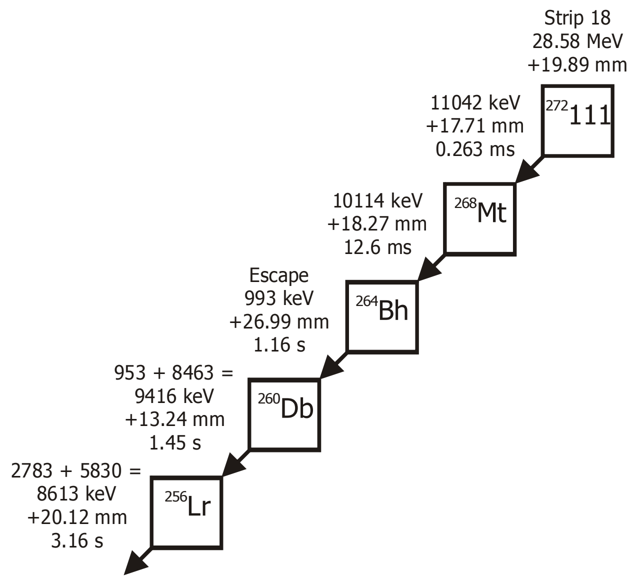

FIG. 1: The event attributed to ^{272}111 in the ^{208}Pb(^{65}Cu, *n*) reaction. The notation $x + y = z$ keV indicates an escape alpha event where x keV was deposited in a strip detector and y keV was deposited in an upstream detector, with sum z keV. Positions are given from -29 mm to +29 mm.

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